

Earth system predictions for marine resource management across space and time scales

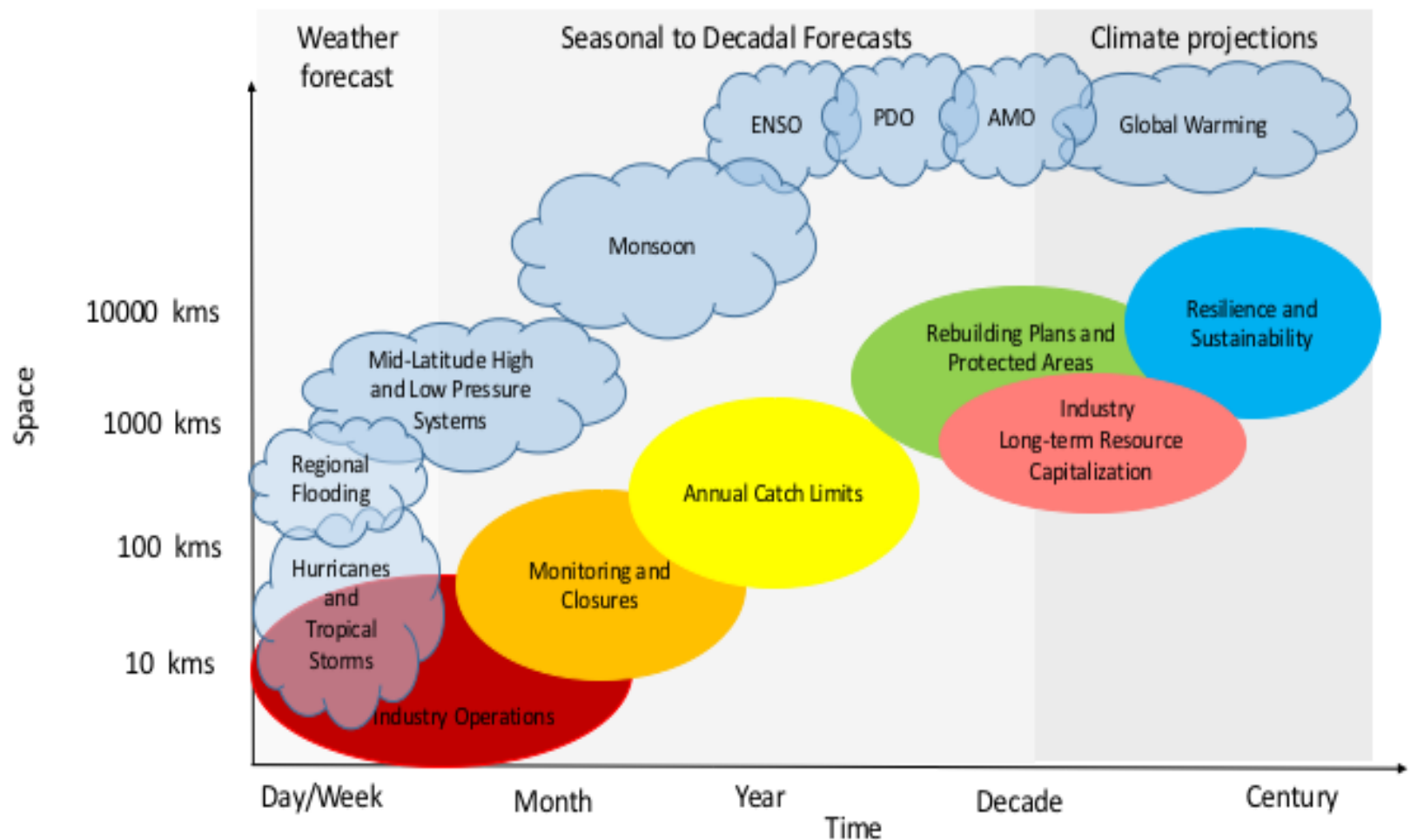
Climate Program Office MAPP Webinar
Unified Modeling for Marine Applications

November 21, 2016

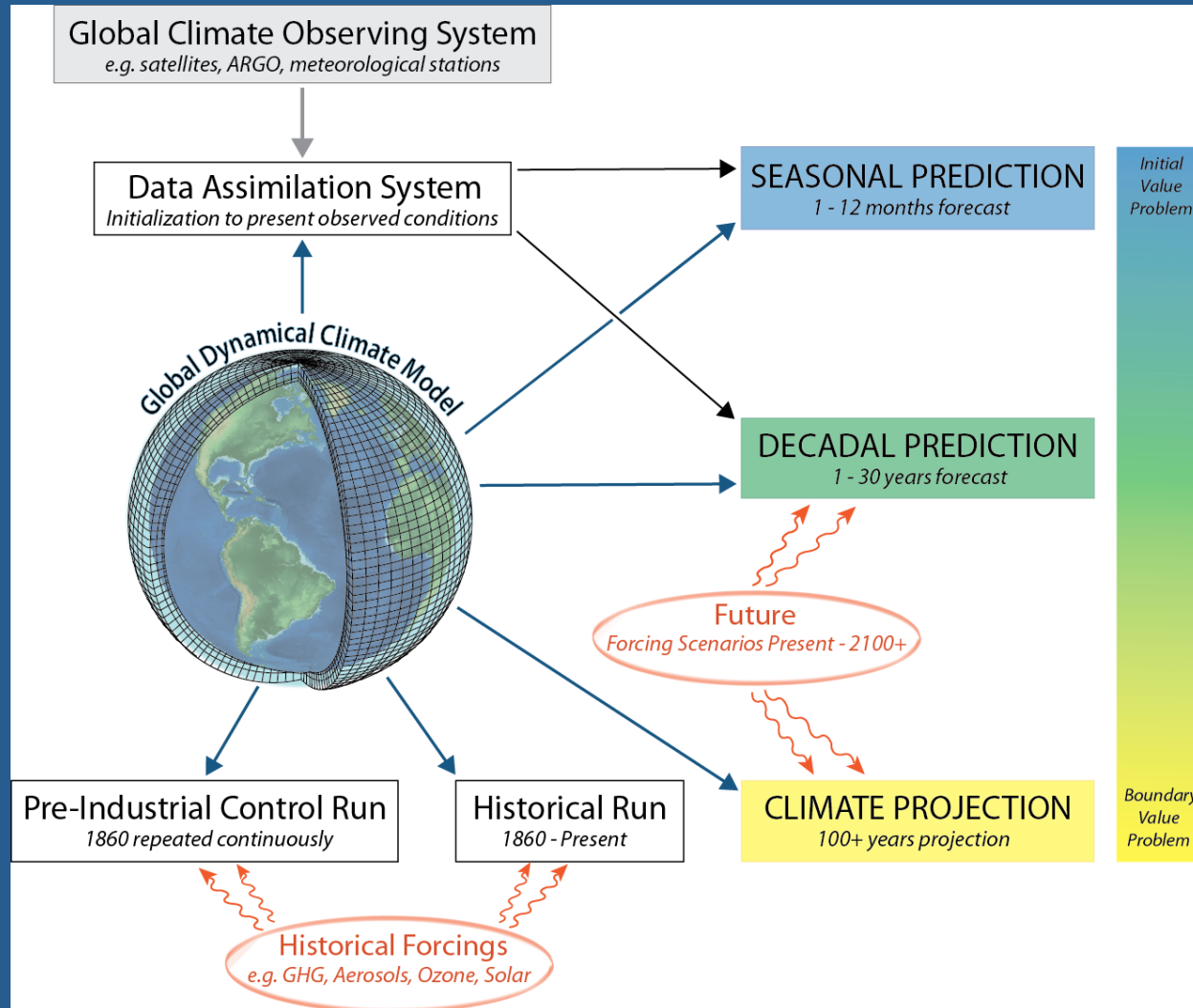
Presented by: Charles Stock (NOAA/GFDL)
(with contributions from many whom
I'll mention throughout the talk)



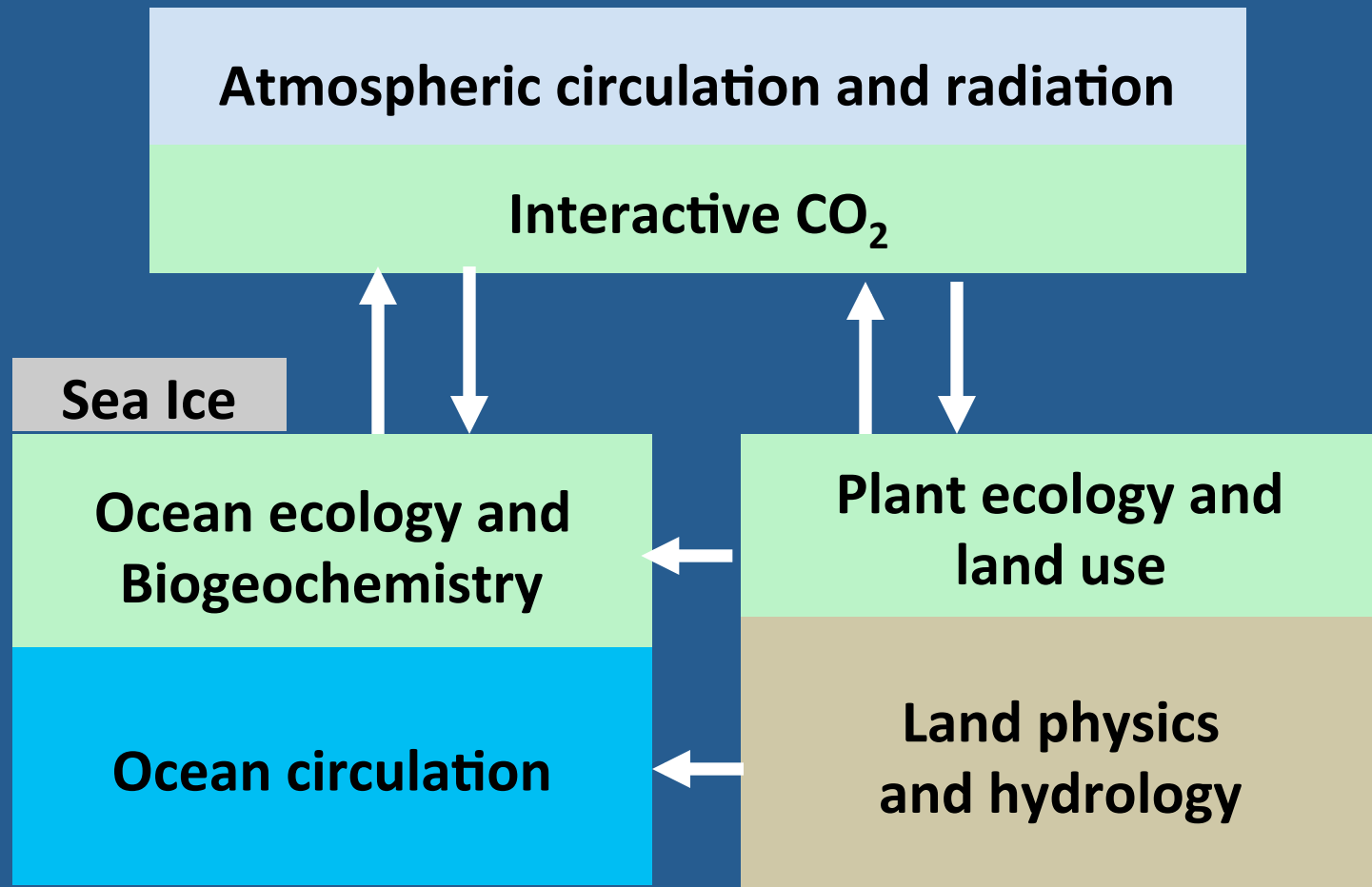
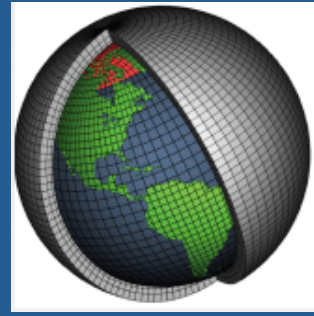
Marine resource management decisions across space and time scales



Seamless climate prediction/projections across time-scales

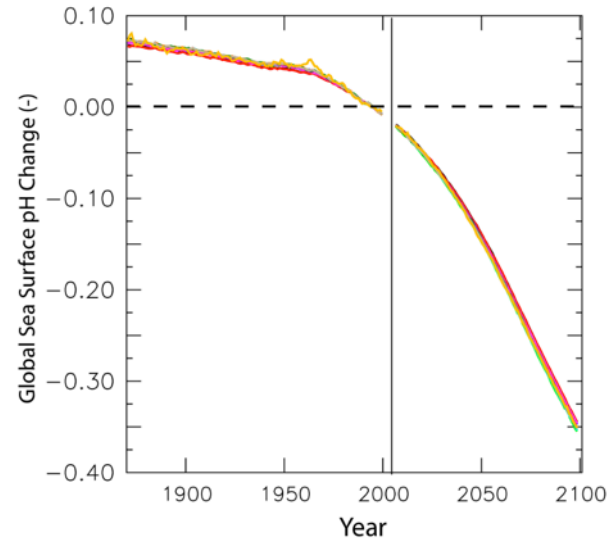
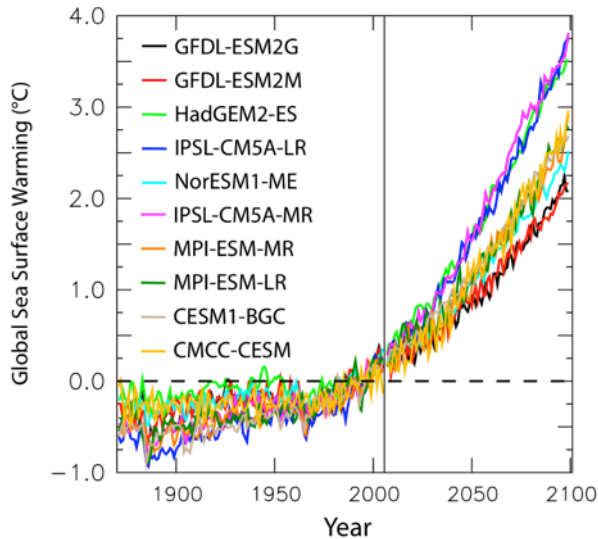


From climate to earth system predictions and projections



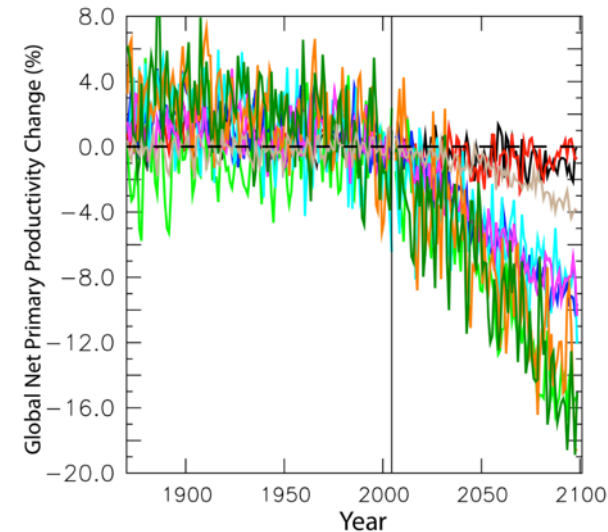
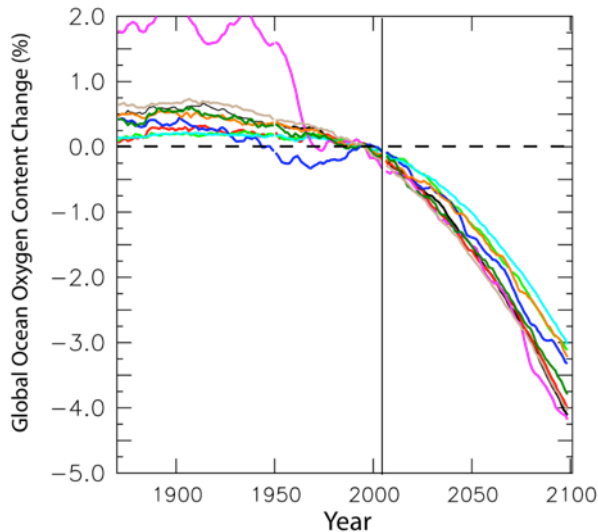
21st century trends in potential ocean ecosystem stressors

SST ↑



pH ↓

O₂ ↓



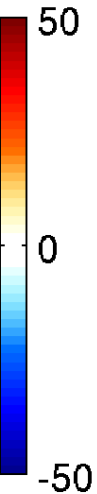
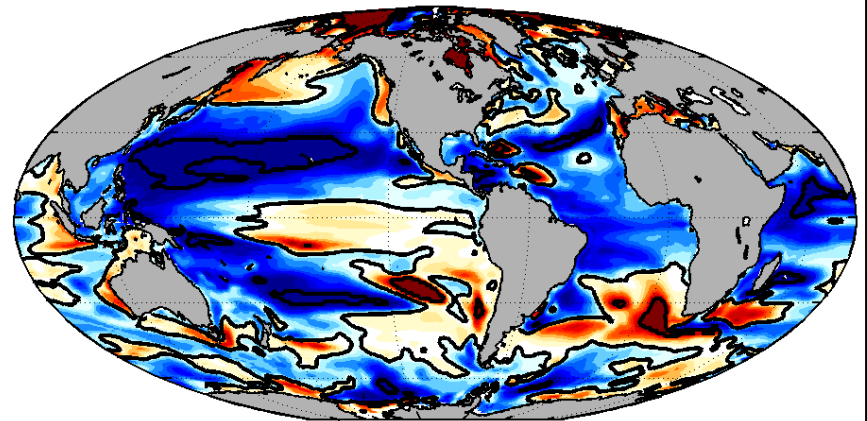
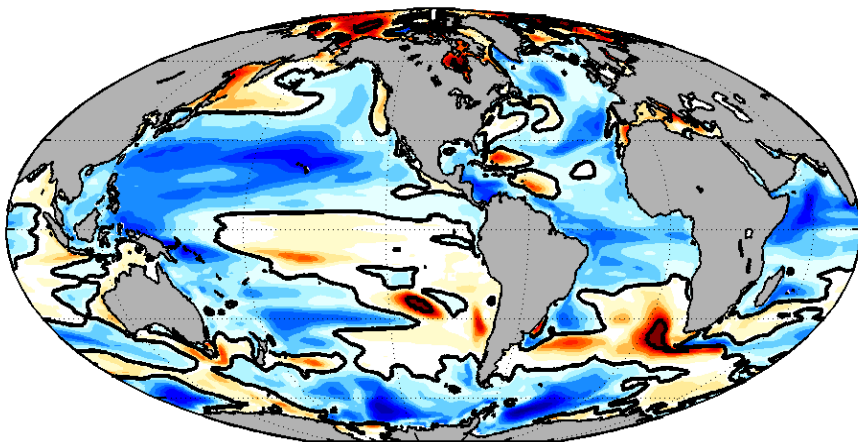
NPP ↓

Bopp et al.,
(2013)

Potential for large regional NPP changes that are amplified at higher trophic levels

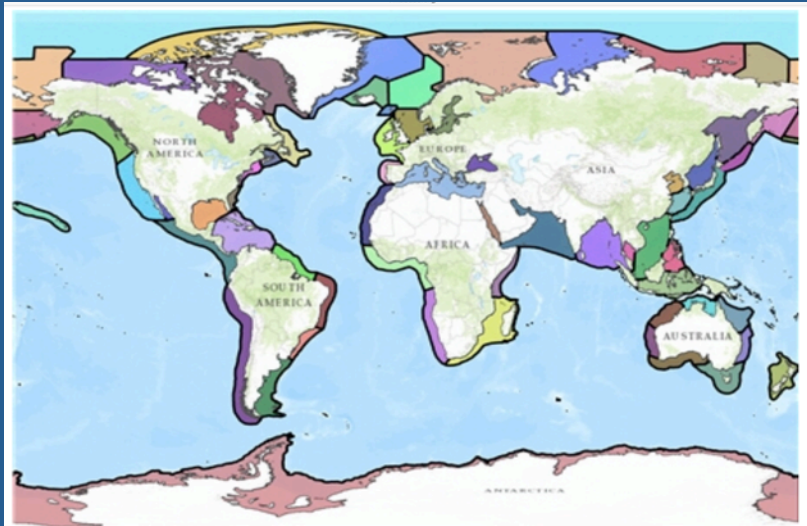
% NPP Change (-3.6%)

% MESOZP Change (-7.9%)

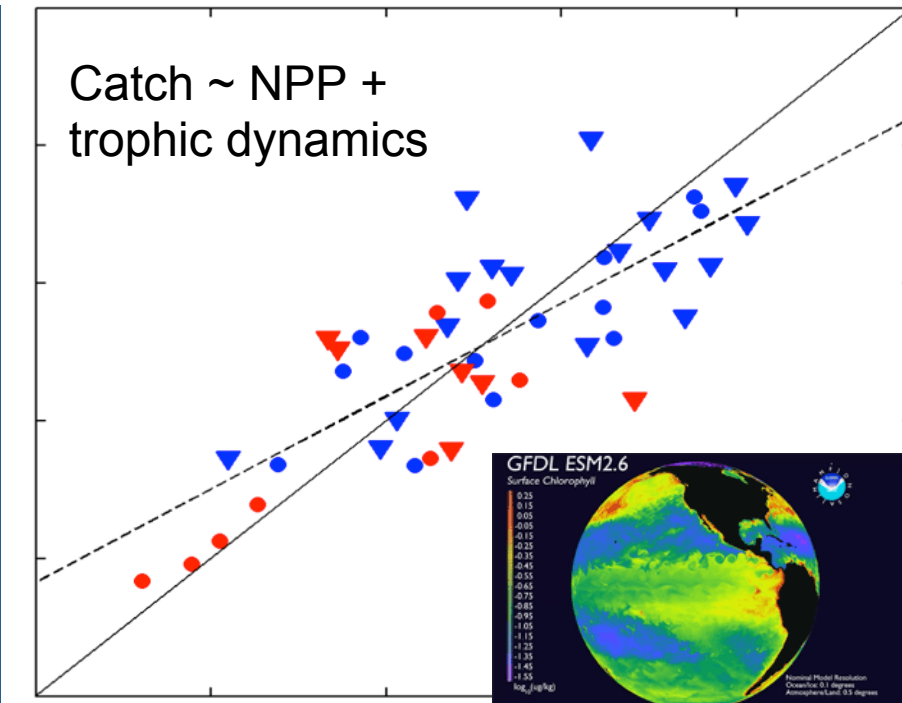
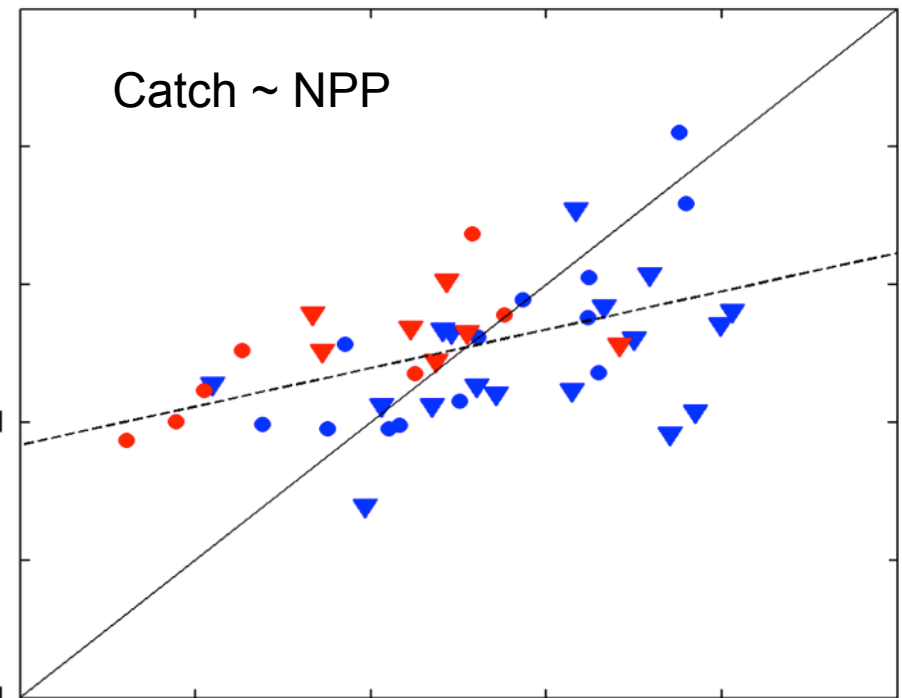


Projected changes in mesozooplankton production can exceed a factor of 2 at regional scales

What does this mean for regional changes in fisheries catch?



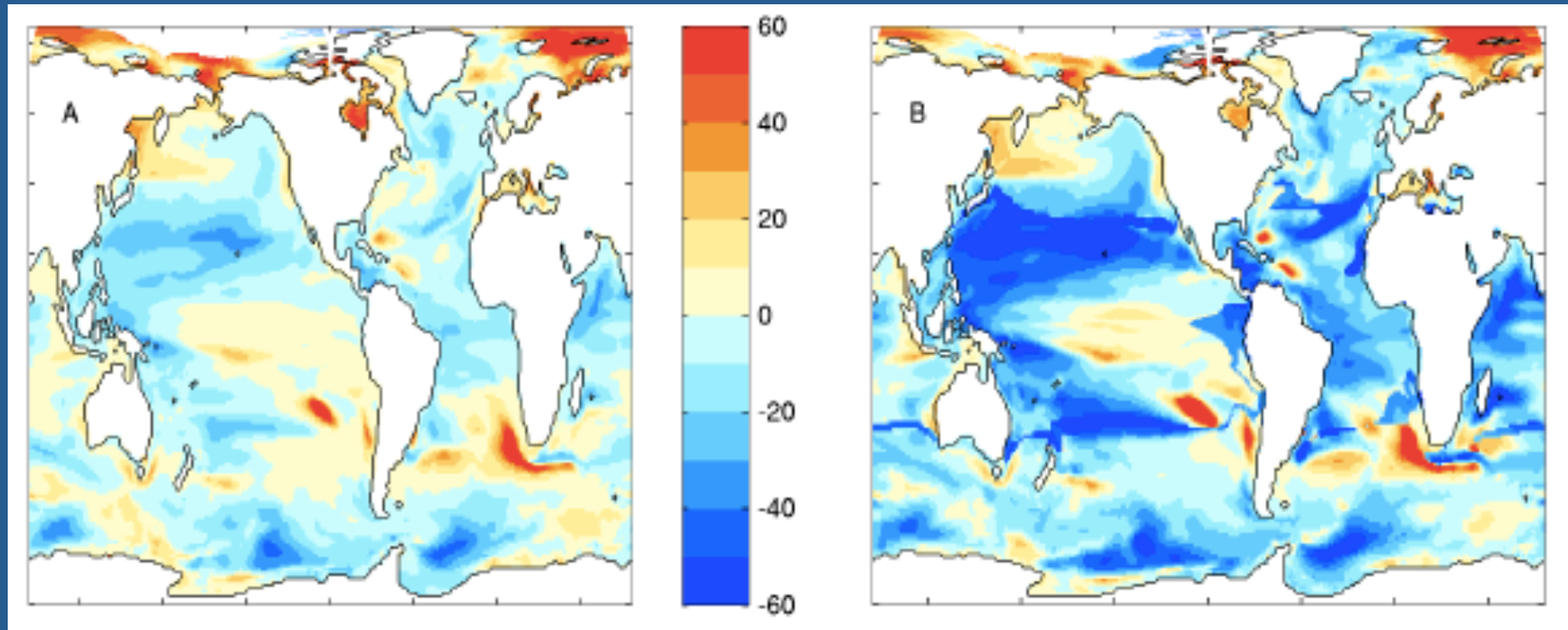
Sherman and Alexander, 1986



Regional fisheries catch trends also amplified relative to NPP under climate change

% NPP change

% Catch change



$$100 * ((2051-2100) - (1951-2000)) / (1951-2000); \text{RCP8.5}$$

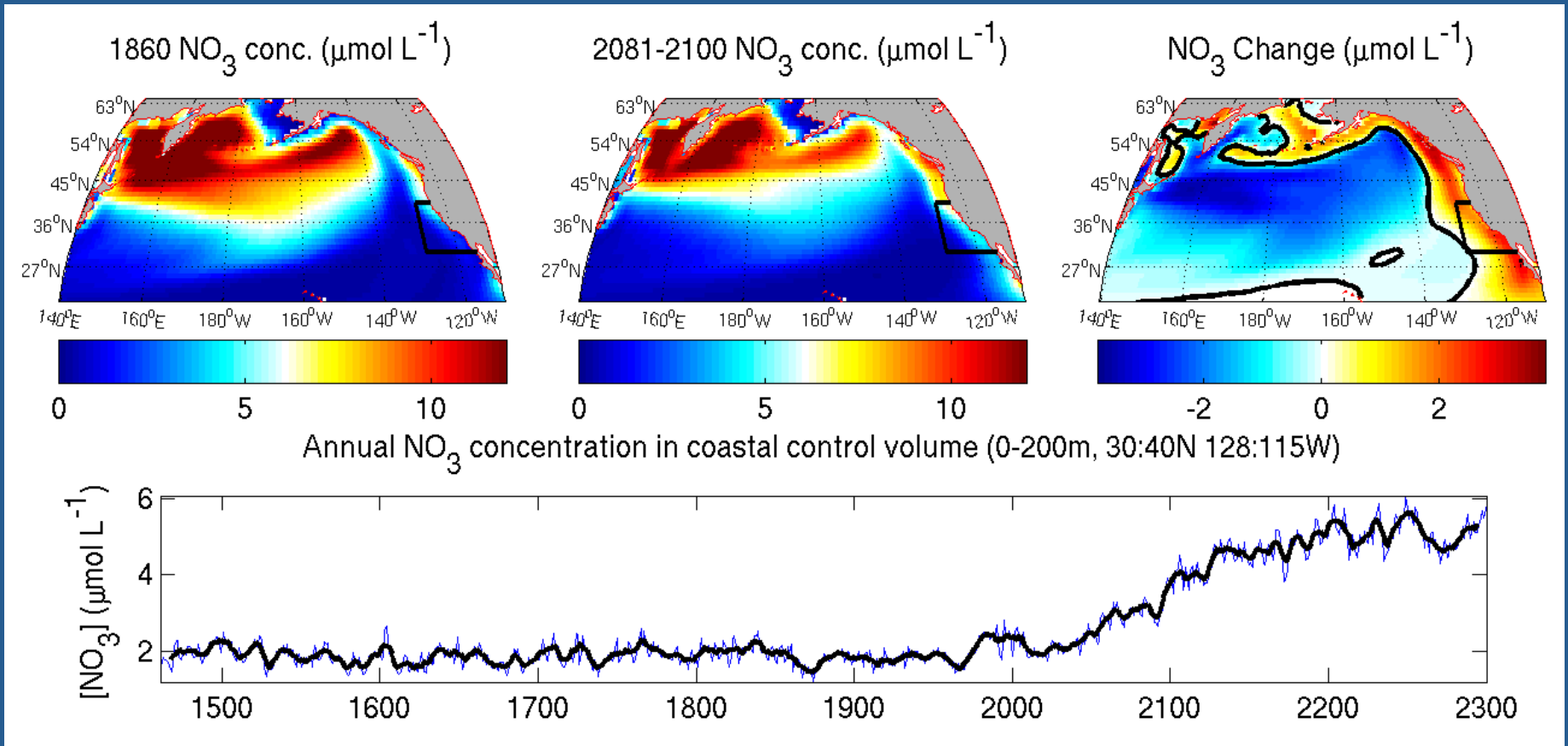
Changing regional baselines

Climate change may produce regional changes in marine ecosystems that greatly exceed oft-cited global values. This is already shaping climate-resilient management, but, if we want to move beyond climate “buffers”, we must do better!

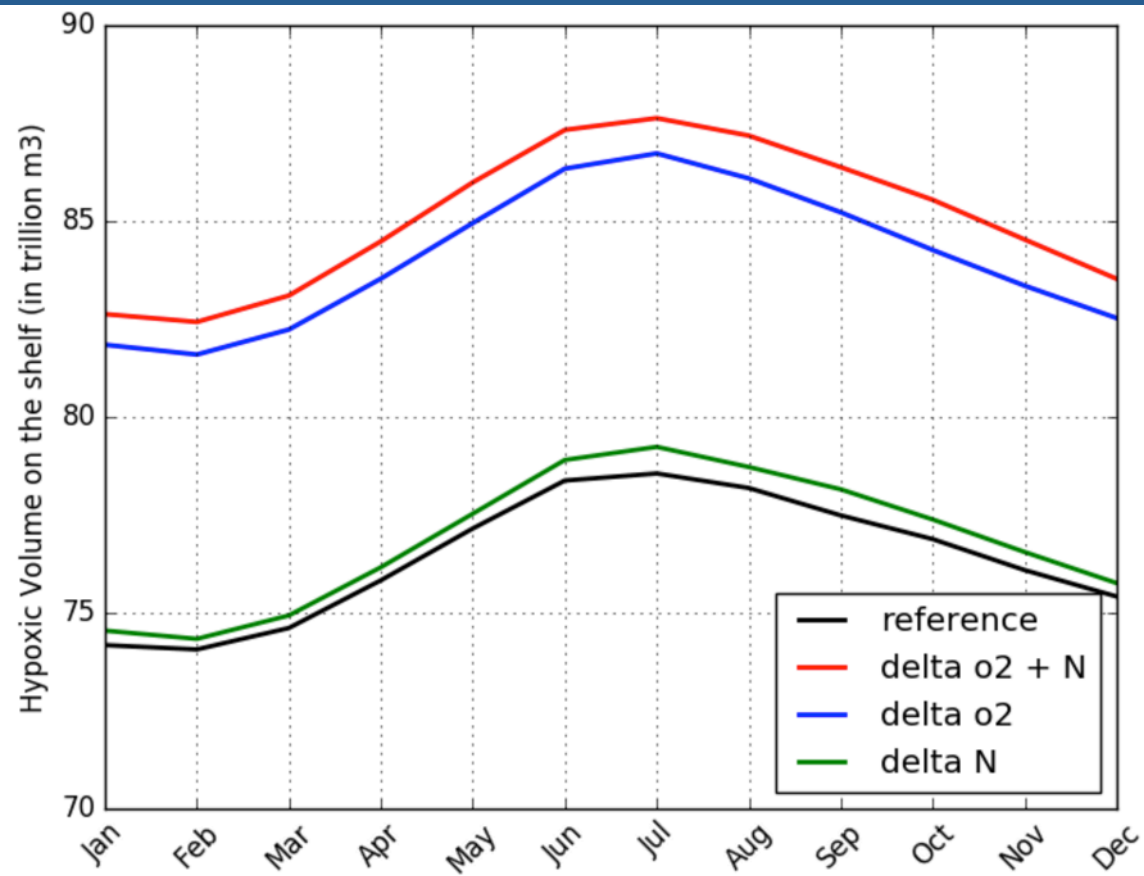
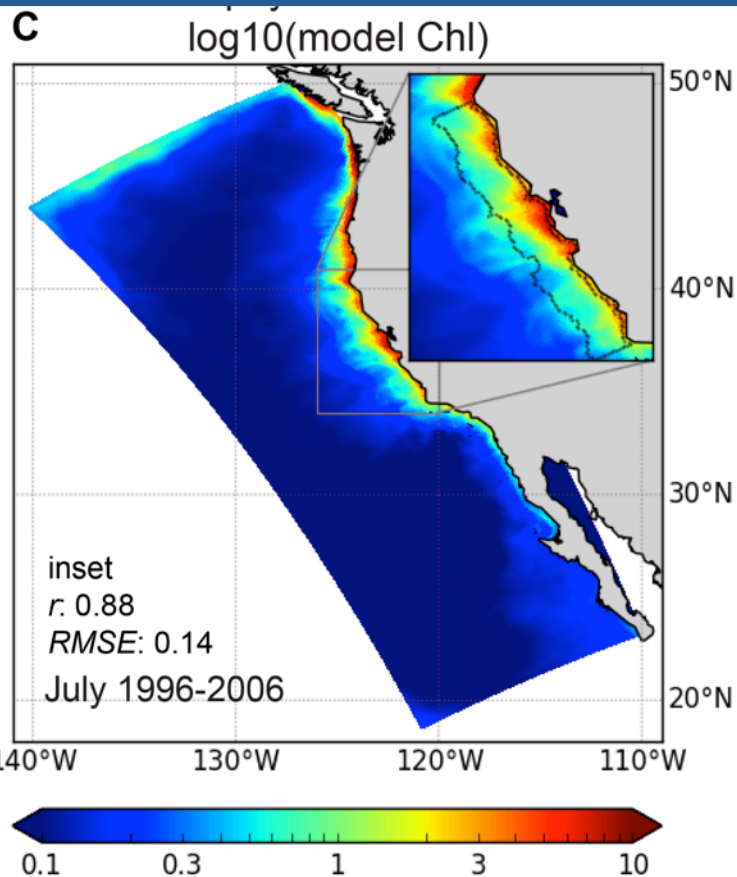
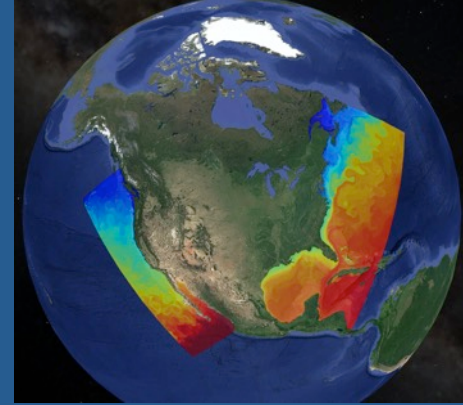
Why still large uncertainty in regional climate projections?

- Stubborn regional biases in global climate models
- Impacts of unresolved local scale processes
- Uncertainties in ecosystem response to climate drivers

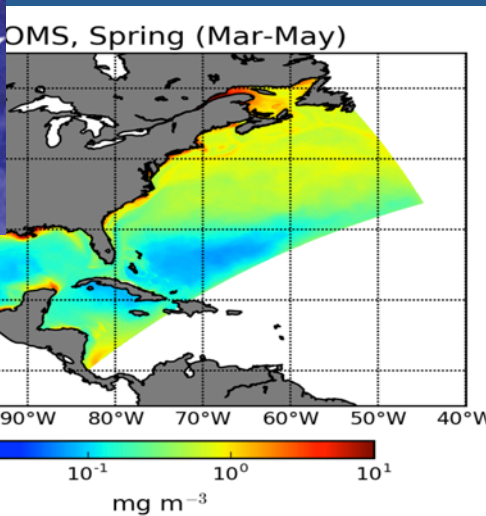
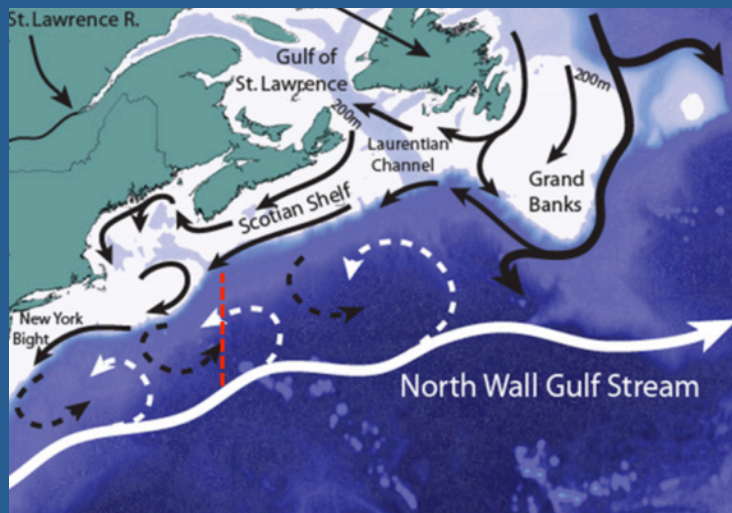
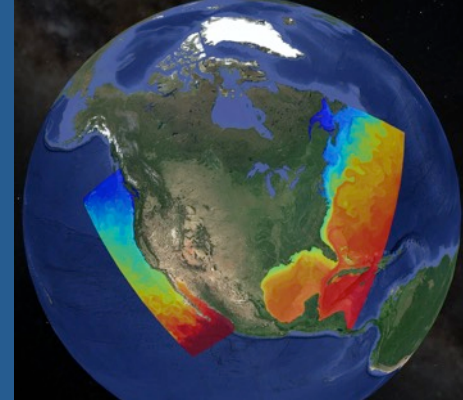
Elucidating basin-scale mechanisms that may contribute to regional biogeochemical change



Regional response to basin-scale biogeochemical drivers in California Current



Regional response to basin-scale biogeochemical drivers in Northeast US Shelf

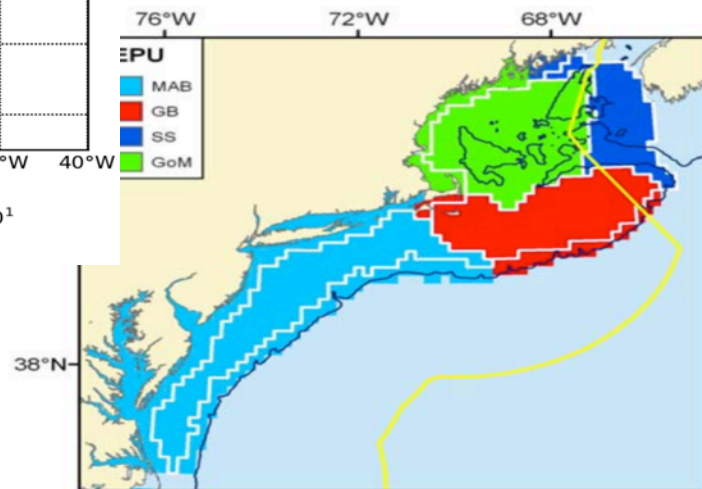


Saba et al., 2016

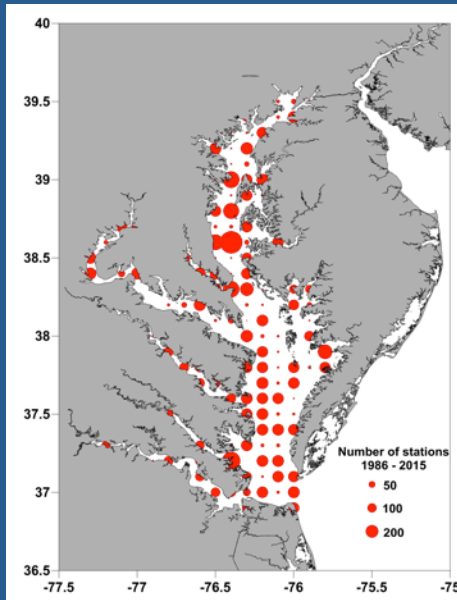
Zhang et al., in prep

CPO/COCA

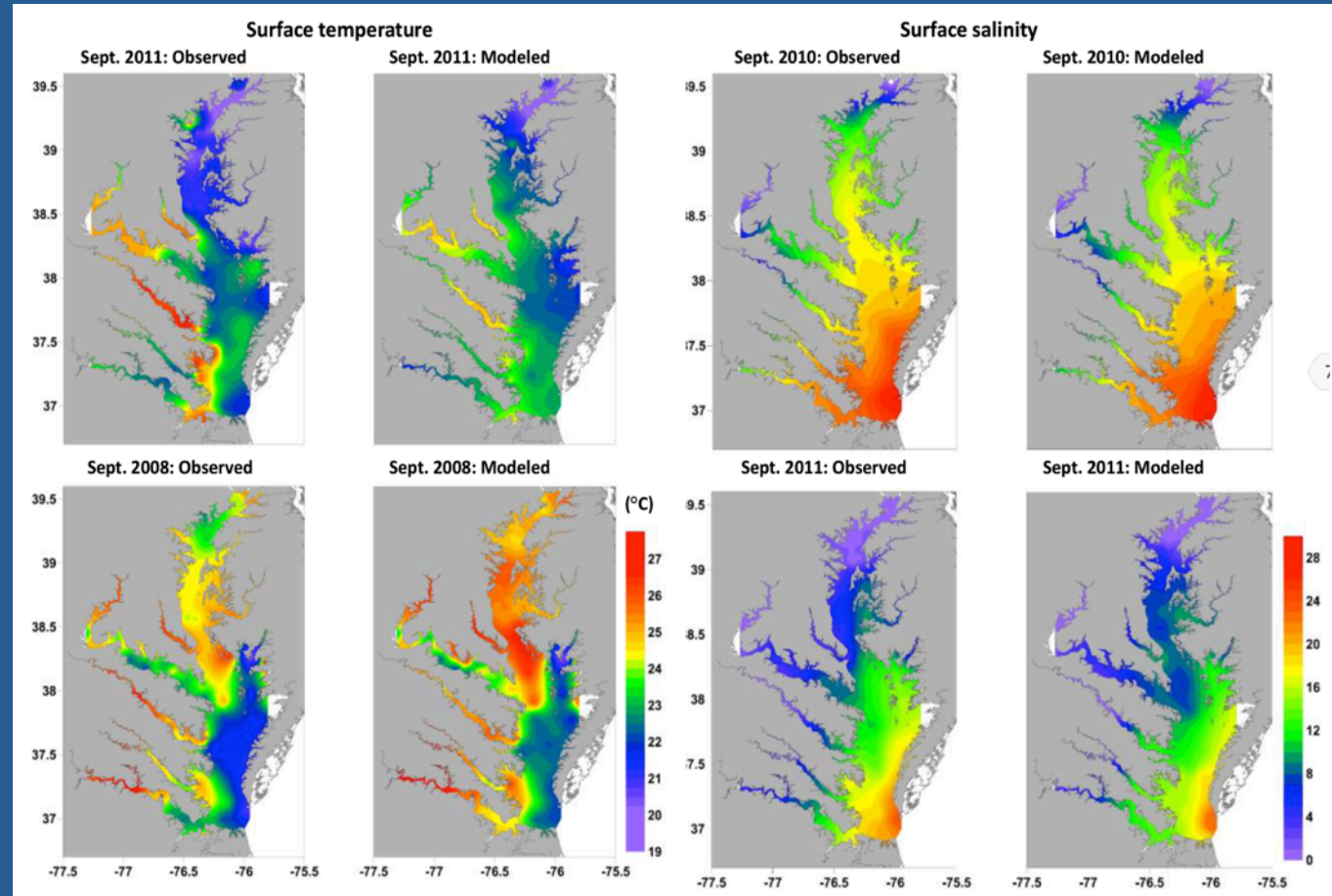
NMFS/NEFSC



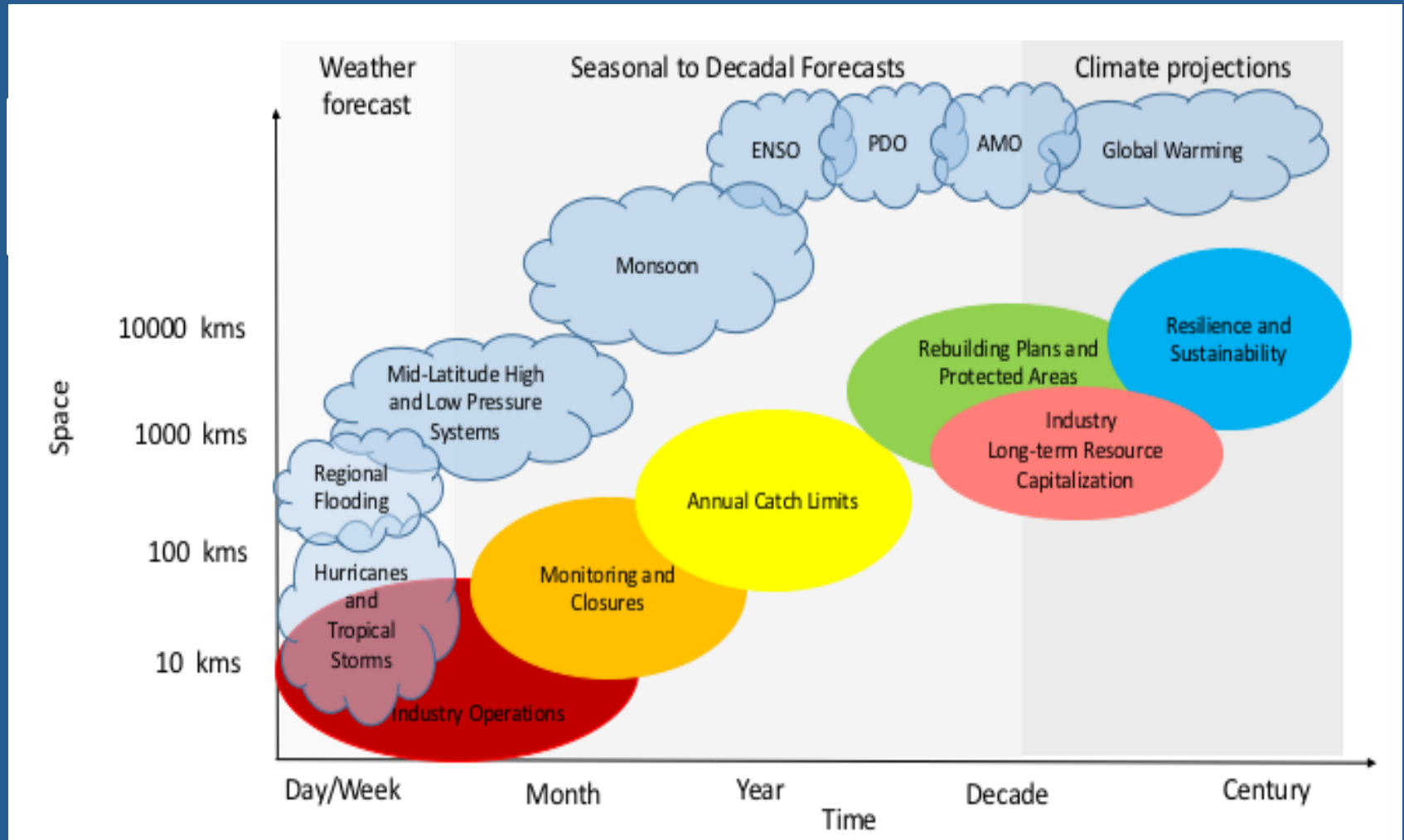
Extending to estuary-scale projections using a statistical-dynamical approach



300-600 CTD casts every summer for more than 30 years

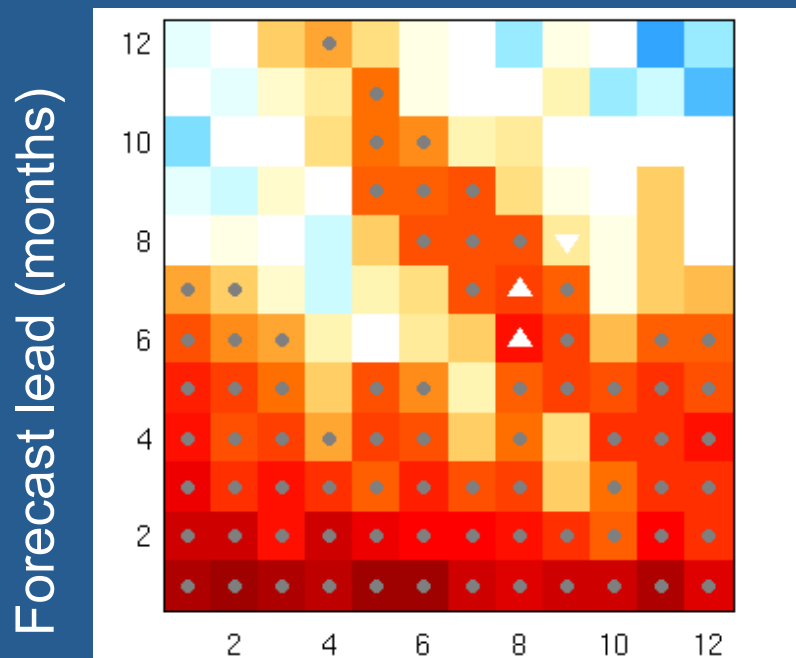


Marine resource management decisions across space and time scales



Seasonal sea surface temperature prediction for coastal ecosystems

California Current SST
anomaly correlation coefficient

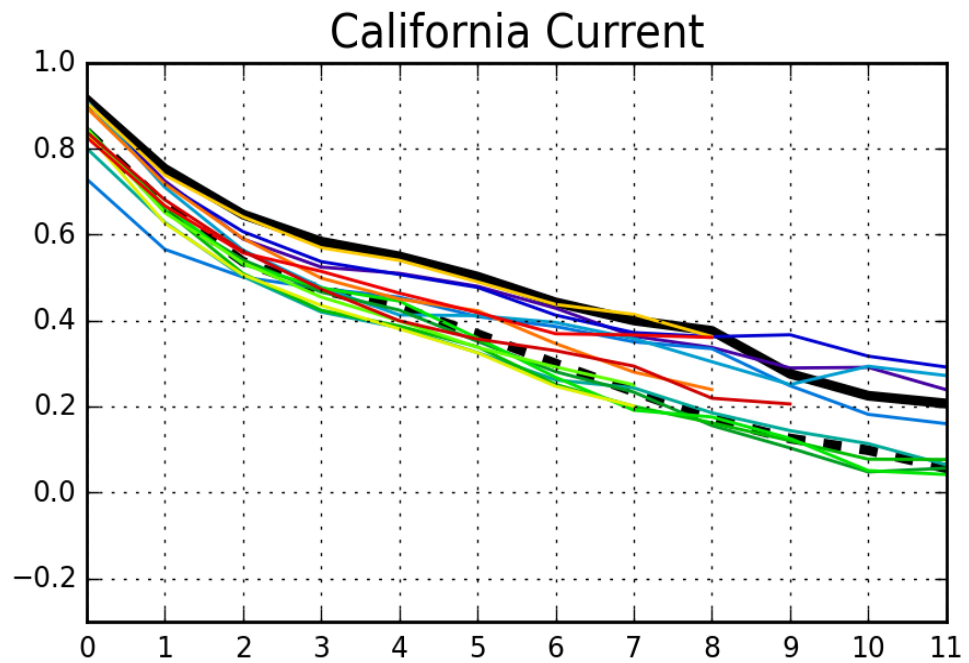


Forecast initialization month



OAR-SEED/CPO

Improved prediction from the North
American Multi-Model Ensemble

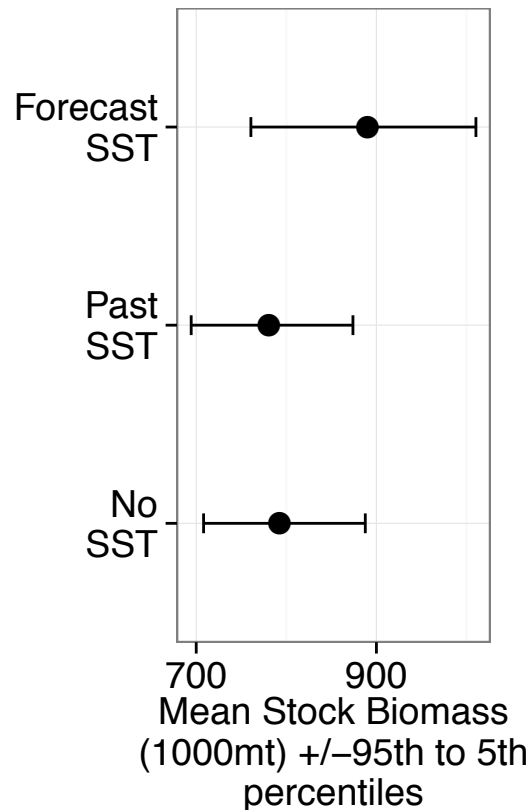
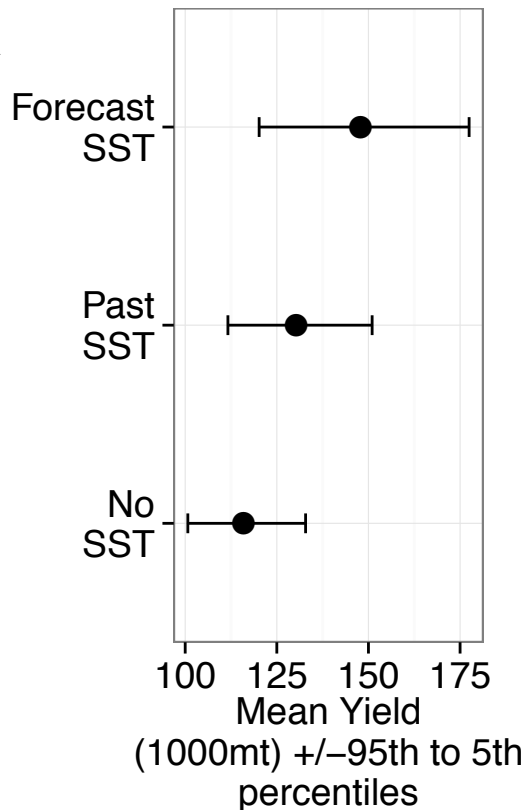


Stock et al., 2015; Hervieux et al.,
submitted; Jacox et al., submitted

Improved management through seasonal climate prediction



Environmental Considerations ↑



Skillful SST
forecast generated



- higher stock biomass
- higher catch
- lower risk of collapse if combined with existing harvest cutoff

What is the optimal initialization strategy for Earth System Forecasts?

Monthly to Decadal Earth System Predictions

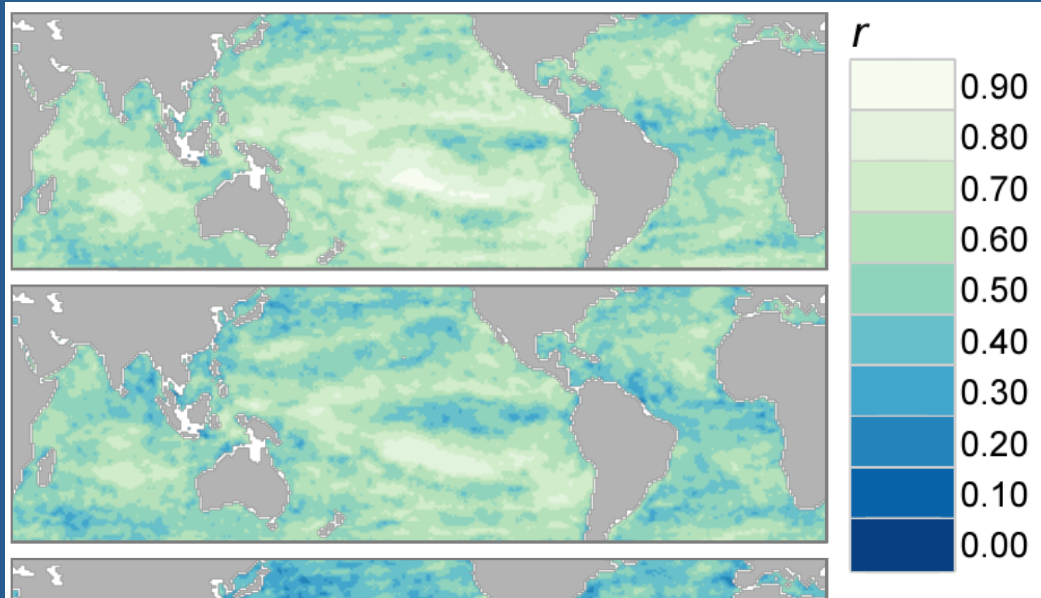
What are the limits of Earth System Predictability?

How well do our Earth System Models represent this response?

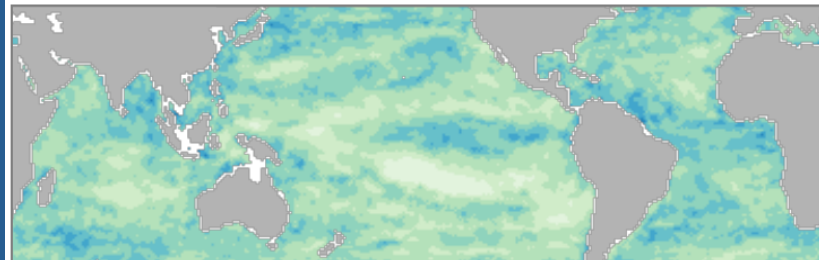
How do ecosystems integrate and respond to climate variability?

What are the predictability limits of ocean productivity?

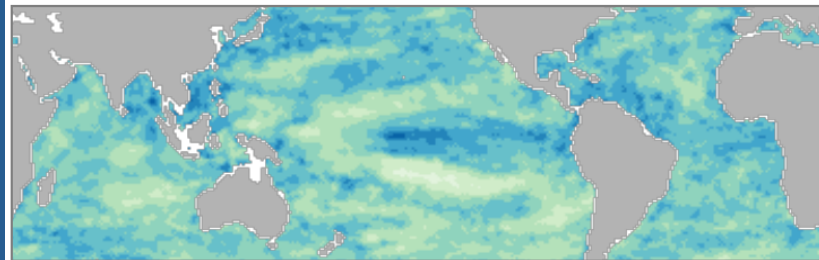
3 months



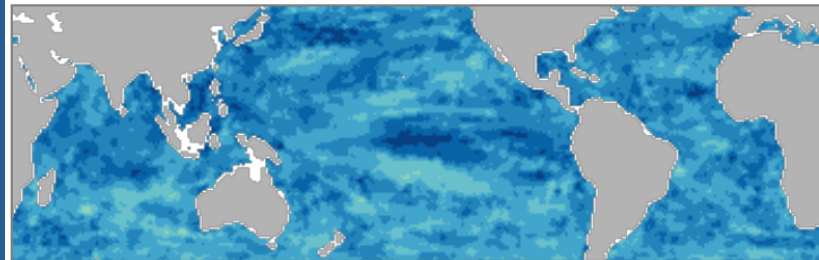
6 months



1 year



2 years

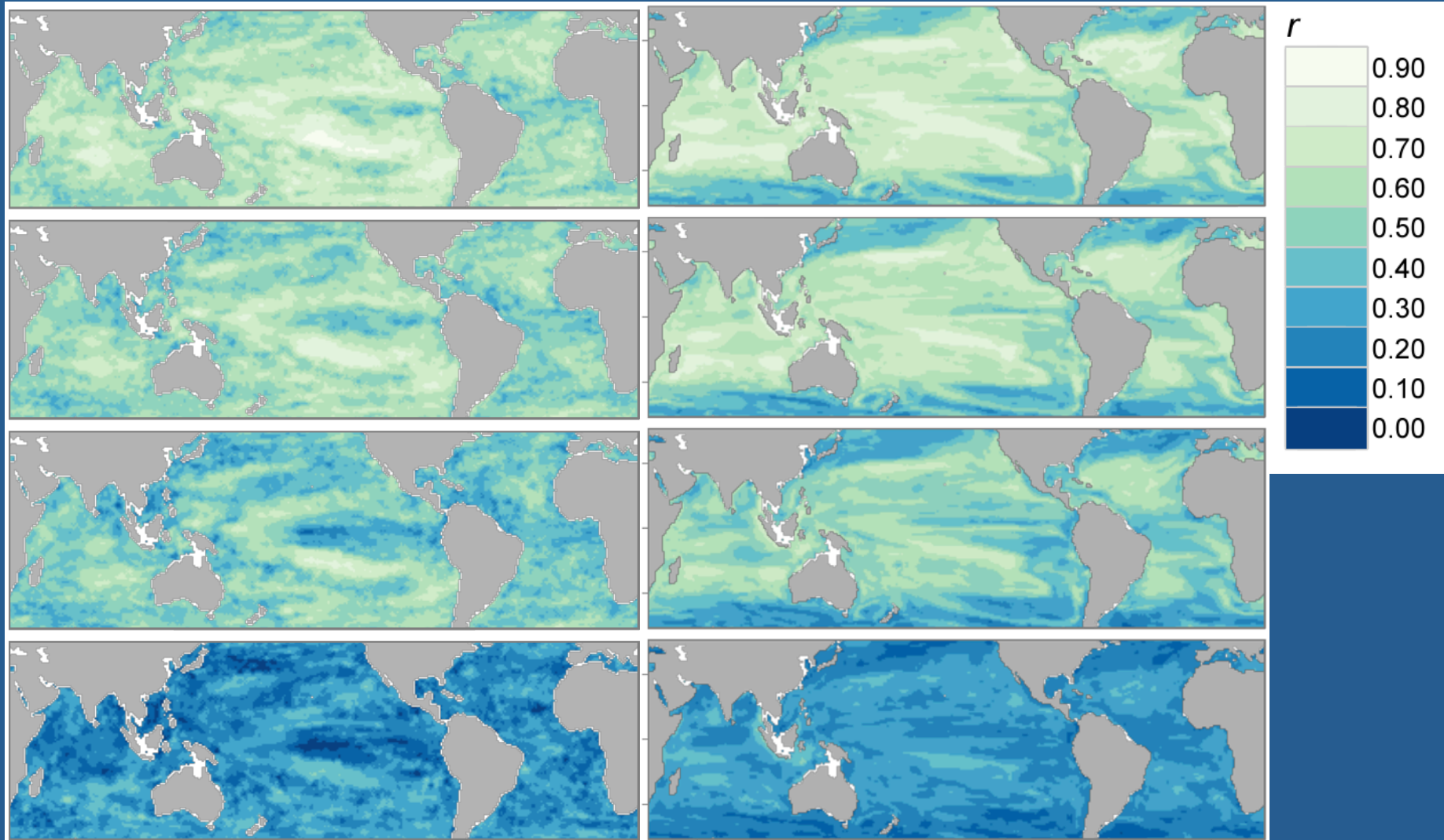


Taboada et al.,
in preparation

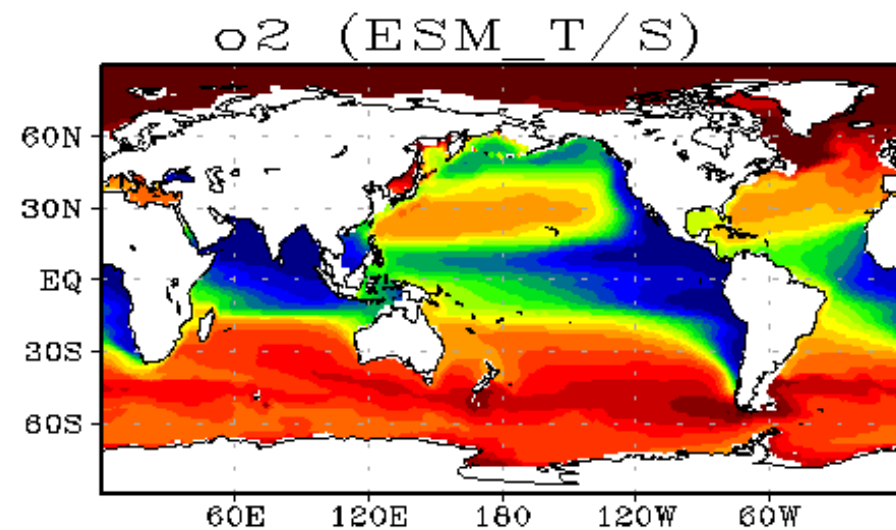
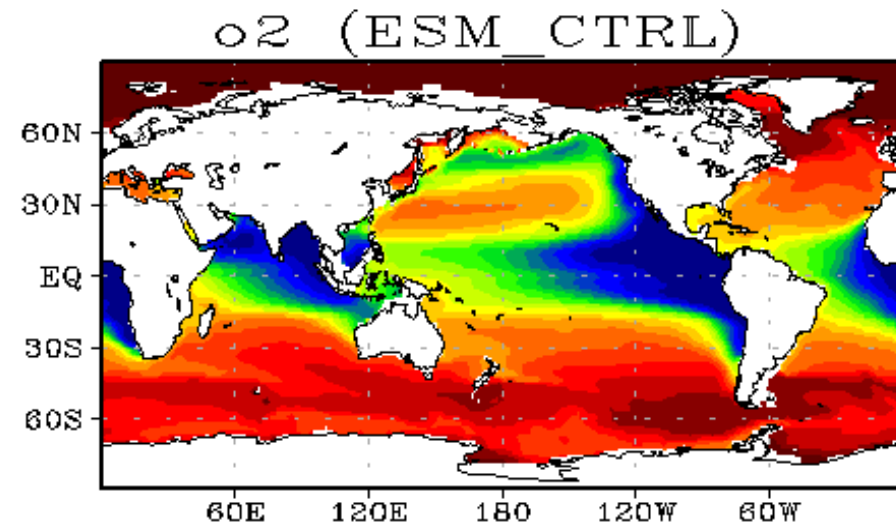
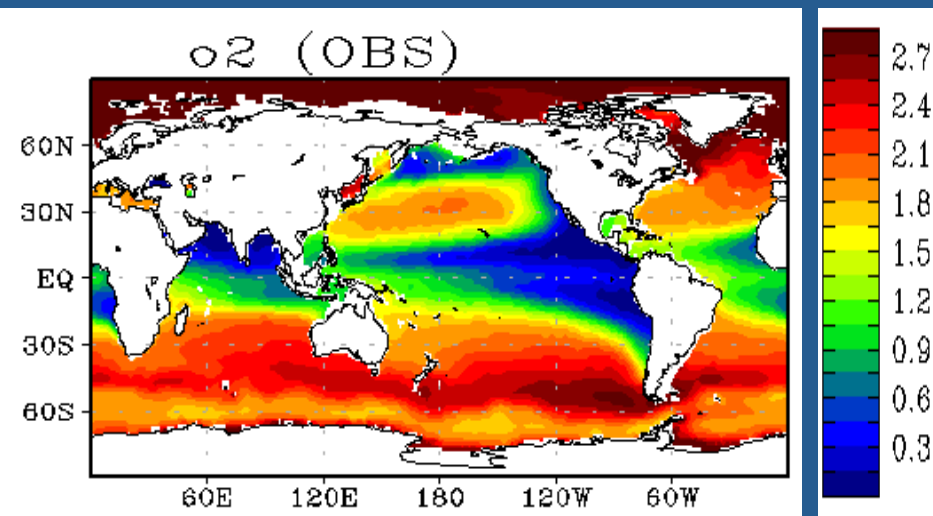
Consistent predictability patterns between satellite and ESM2M-COBALT

Satellite-based NPP

ESM2M-COBALT



Integrating biogeochemistry GFDL's Ensemble Coupled Data Assimilation System



Earth system prediction to support marine resource management, on the horizon

- Seamless Earth system prediction across time and space scales
- Holistic linkages between terrestrial and ocean systems (coastal eutrophication, pollution, blue carbon)
- Seasonal estuarine forecasts
- Mechanistic global fish, jellyfish, and fishing models

Additional Funding sources

- OAR SEED Project/CPO SEED extension
- NMFS S&T
- OAR Marine Ecosystem Tipping Points Initiative
- CPO/COCA Northeast US fisheries and climate
- Nippon Foundation/Nereus Program
- NOAA Integrated Ecosystem Assessment Program (California Current & Northeast)
- NOAA NOS National Centers for Coastal Ocean Science
- Princeton Cooperative Institute for Climate Sciences